UNIVERSITI TEKNOLOGI MARA

TRANSFER MATRIX METHOD FOR IDENTIFYING THE DYNAMIC CHARACTERISTICS OF AN EXHAUST SYSTEM

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Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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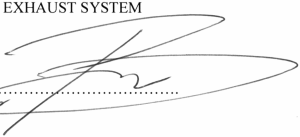

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ABSTRACT

There are a number of modelling procedures and methods for the analysis of dynamic characteristics of structures available. The selection of the procedures and methods is very important, in particular the computational accuracy and speed and the operating cost. Numerical technique based on Transfer Matrix Method can be an alternative viable option that offers fast initial prototype solutions for designers. The purpose of the research was to present an alternative method for the identification of the dynamic characteristics of continuous systems or single line type structures in place of commercially available software, in particular at the preliminary design evaluation stage. The natural frequencies and mode shapes of the structures were the items of interest in the dynamic characteristics analysis. The alternative method which is the Transfer Matrix Method was developed based on the wave equations of longitudinal vibration and lateral vibration of beam and numerically supported by FORTRAN source code. For preliminary validation and test of accuracy and efficiency, the developed method was applied to a 3D simple pipe. The numerical results obtained were compared to the results calculated from commercial computer simulation software (MSC PATRAN/NASTRAN). The results showed good agreement with the maximum contrasting value of natural frequencies was 0.48Hz. The developed method was then applied to a more complex structure which is an exhaust system, considered as a case study of this research. The numerical results of natural frequencies and mode shapes derived from the developed method were again compared to the numerical results obtained from the commercial software. The numerical results of the natural frequencies and mode shapes also showed good qualitative agreement in the comparisons of the results calculated from the commercial computer simulation software. The maximum contradiction of natural frequencies between the developed method and commercial computer simulation (MSC PATRAN/NASTRAN) was only 0.57Hz. The qualitative good agreement between the developed method and commercial computer simulation shows that the developed method offered good capacity and also inexpensive cost for identifying the dynamic characteristics of the continuous systems.

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

Structural vibration problems continue to present a major hazard and design limitation for a very wide range of engineering products today D.J. Ewins [61]. First, there are a number of structures, from exhaust systems, turbine blades, crankshafts to suspension bridges, for which structural integrity is of paramount concern, and for which a thorough and precise knowledge of the dynamic characteristics is essential. Then, there is an even wider set of structural components or assemblies for which vibration is directly related to performance, either by virtue of causing temporary malfunction during excessive motion or by creating disturbance or discomfort, including that of noise. For all these examples, it is important that the vibration levels encountered in service or operation be anticipated and brought under satisfactory control.

Due to the devastating effects that vibrations can have on structures, modal testing and modal analysis have become a standard approach in the design and development of most engineering systems M. L. James [7]. In many engineering systems, a human being acts as an integral part of the system. The transmission of vibration to human beings results in discomfort and loss efficiency. For instance vibration of instrumental panels can cause their malfunction or difficulty in reading the meters, meanwhile vibration of exhausts system can lead to uncomfortable to driver and passengers of vehicle. Thus one of the important purposes of vibration study is to study the dynamic characteristics of system or structure, in particular natural frequencies and mode shapes in order to reduce